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Intelligent Space and Ontological Network System

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***Abstract*-The robot has recently emerged as a factor in the daily lives of humans, taking the form of a mechanical pet or similar source of entertainment. A robot system that is designed to co-exist with humans, i.e., a coexistence-type robot system, is important to be "it exists in various environments with the person, and robot system by which the interaction of a physical, informational emotion with the person etc. was valued". When studying the impact of intimacy in the human/robot relationship, we have to examine the problems that can arise as a result of physical intimacy (coordination on safety in the hardware side and a soft side). Furthermore, We should also consider the informational aspects of intimacy (recognition technology, and information transport and sharing).**

I. INTRODUCTION

The symbiosis of the human existence and the intelligent robot assumes that the robot is capable of being safely integrated into the human environment. That is, an intelligent robot can be endowed with autonomy and the capacity to interact intimately with humans. Human nature is such that when we are not working, we like to indulge in leisure-time activities. These activities and their characteristics vary depending on one's life style. An intelligent robot must be capable of subjectively understanding human nature to interact safely. We describe here a system we designed that provides a robot with an autonomous function and a learning function. The good actions of the robot were learned from interaction between human and robots, and it was experimented in the real machine robot. The good actions that satisfy both human and robots are acquired from human's subjective evaluation as well as the emotion of the robot.

We studied the resulting human and robot symbiosis using the system composed. The learning method used is different from a general reinforcement learning method though it assumes that reinforcement learning is fundamental.
In a word, a reinforced signal depends on the evaluation of a human and the value of the robot, and the value changes by simulated feelings of the robot. Moreover, a smooth communication was enabled by sharing the studied action with other agents according to an environmental information *situation*

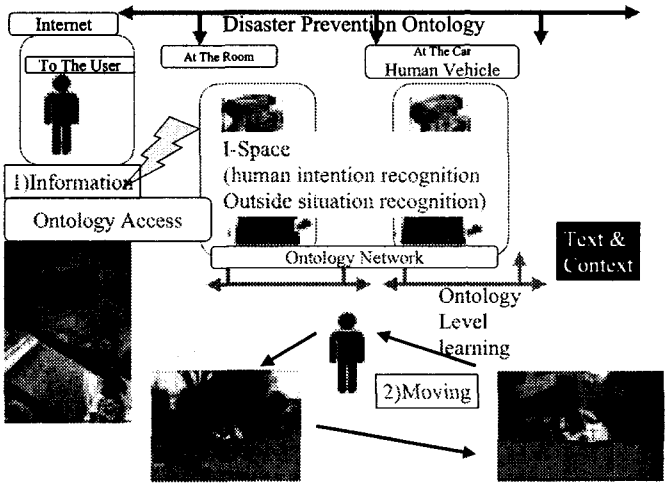


Fig.1 Ontology based Network Intelligent System

II. ACTION RECOGNITION OF HUMAN

In the symbiosis of human and robot, the robot should understand specific instruction as well as non-specific instructions given by a human. In this research, Fuzzy Associative Memory (FAM) is used so the robot can understand instructions that are conveyed directly by the human as well as those that come from the human's

environment. FAM is composed of a front layer of fuzzy rule (If layer) and a back layer (Then layer). The rule layer by which one node represents one rule is set. The fuzzy rule is expressible by using the composition of the BAM (Bi-directional Associative Memory) between the If layer and the Then layer. (Fig. 2)

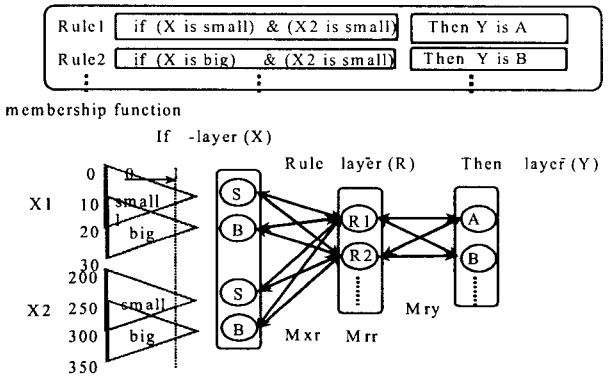


Fig.2 FAM

In this study, Intelligent Space software (ISpace) was used to recognize the position of the human's hand and the position of the robot. ISpace can recognize a user's skin color (color information) and the position information of human and the robot. (Fig.3) The human's hand position obtained by ISpace is treated as time series data. The value of the point of inflection is processed by FAM, and it is then inferred what the operation is being observed.

Fig.3 Intelligent Space

III. ONTOLOGY

The word "ontology" means a "systematic theory of existence" in the study of philosophy. Philosophically aiming to arrange everything in the systematic world, it is called Ontology. We show the ontological concept and the proposal model in Fig. 4.

The research into ontology has been performed to study the problem of "Share of knowledge" and "Construction of the knowledge base" in the field of the knowledge processing.

The knowledge processing system constructs the knowledge base of the targeted world by using Ontology (Fig.5).

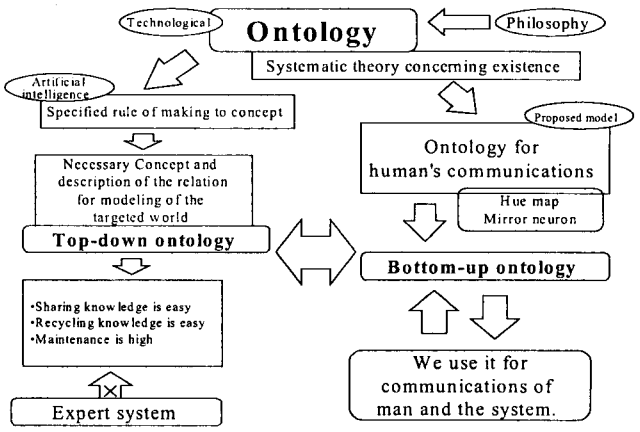


Fig.4 Ontology and proposed model

A contribution to knowledge sharing can be expected to result by studying the targeted concept. The ontology proposed here is of the knowledge-construction type and is used to communicate to the human and the system.

This ontology is called a bottom-up ontology. Ontology is composed of Conceptual Fuzzy Sets (CFS) that has the dispersive express of concept.

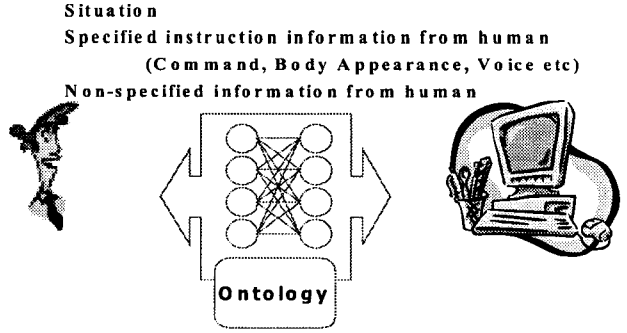


Fig.5. Ontology image in interface

IV. CONCEPTUAL FUZZY SETS

The label of a fuzzy set represents the name of a concept and the fuzzy set represents the meaning of the concept.

According to the theory of meaning representation from use proposed by Wittgenstein, the various meanings for a label (word) may be represented by other labels (words) and thus grades of activations, which show the degree of compatibility between different labels, can be assigned. The distributed knowledge called Conceptual Fuzzy Sets (CFS) is shown in Fig.5. Since the distribution changes depending on the

activated labels indicating the conditions, the activation resulting from the CFS displays a context-dependent meaning. Thus, a CFS can represent not only logical knowledge, but also knowledge whose representation is logically impossible.

In this article we use BAM (Bidirectional Associative Memories) because of the clarity of constraints for their utilization. At the association in BAM reverbrations are carried out according to equation (1).

$$X_{t+1} = \phi(M^T * Y_t) \quad (1.1)$$

$$Y_t = \phi(M * X_t) \quad (1.2)$$

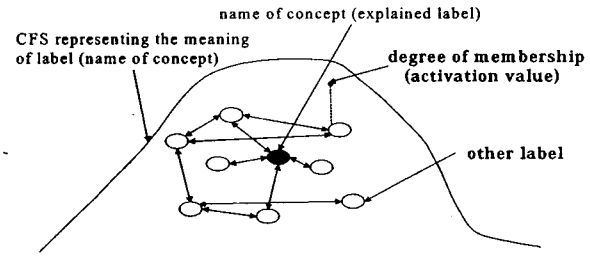


Fig. 6.Image of conceptual fuzzy sets in associative memories

Where, $X_t = [x_1, x_2, \cdots, x_m]^T, Y_t = [y_1, y_2, \cdots, y_n]^T$ are activation vectors on x and y layers at the reverberation step t, and $\phi(*)$ is a sigmoid function of each neuron. The correlation matrices M and MT are given by equation (2). β is an association parameter

$$M = \beta \sum_{i=1}^{N} y_i x_i^T \qquad M^T = \beta \sum_{i=1}^{N} x_i y_i^T \quad (2)$$

A CFS is composed of individual association matrices Mi(i=1,2,...,n) and can be synthesized according to expression (3). norm[...] is invalid-data conversion rule operation of an association matrix.

$$M = norm[M_1 + M_2 + \cdots + M_n] \quad (3)$$

When the human recollects abstraction concept, the human depends on context. Show in Fig.7, When you hear of the word "guppy", "cat", you must imagine that they are talking about pet. So you recollected pet in brain. When cat and guppy are stimulated in this CFS, upper class concept, "pet", ignites. Tuna vitalized a little. But it is disregarded, because it is nonexistent in great activity value. Similarly, in the below side, when "tuna" and "guppy" are stimulated, the upper class concept "fish" ignites. CFS can form general concept by combination of the other words at all times.

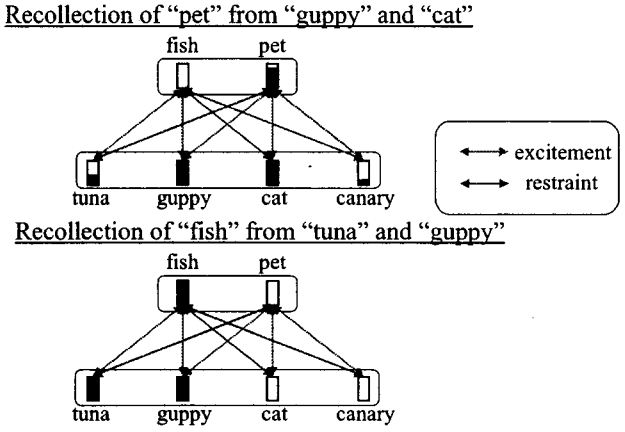


Fig.7 Recollection of the Abstraction concept from the instance

V. ONTOLOGY FOR INFORMATION SHARING

Ontology systematizes the concept to the object. Therefore, a common structure is expected to be formed between the human and some agents. In a word, technological ontology enables some agents to cooperate naturally with human (Fig.8). And on a common abstract base, the agents of a different mechanism can share information.

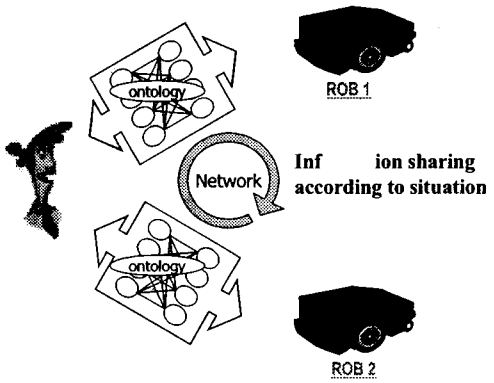


Fig.8. Ontology for information sharing

Figure 9 shows the ontology used by this research. This ontology is composed of the ontology from the human to the agent and the ontology from the agent to human. The agent has the instance corresponding to the instruction of human

and the situation. This instance is acquired by the symbiotic learning. Each agent learns symbiotically according to each situation. The knowledge acquired by a certain situation is shared with other agents that are in the same situation. We think that this sharing method is important for some agents and humans to interact smoothly.

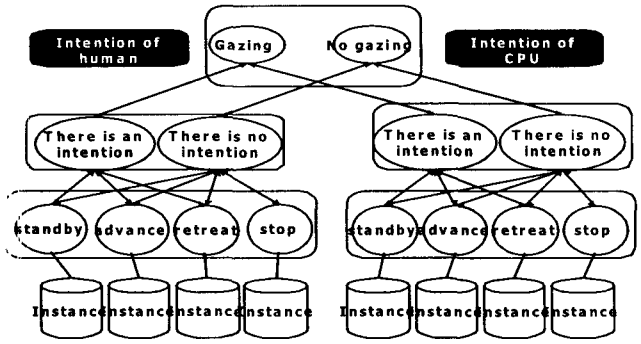
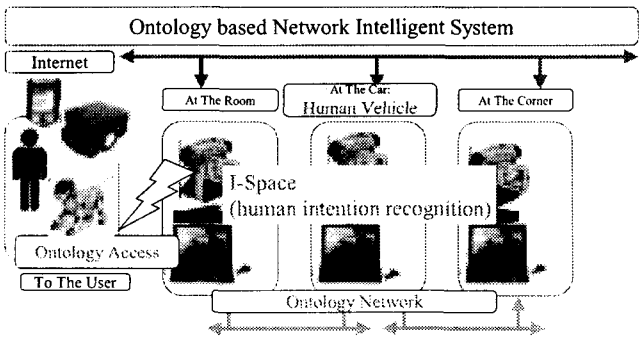


Fig.9. Composition of ontology

VI. CONCLUSION

We reported a demonstration of a robot initiating a voluntary action that was achieved by using the K.E.I. Model. The reward that was dependent on a value for the human and the robot that were both given by using Q-Learning. The action pattern for the symbiosis of a human and a robot was shown in a real machine experiment. Moreover, to promote sharing with agents in the acquisition knowledge in accord with a given situation, an ontology was composed. As a result, this system showed its suitability to be used as a multi-agent system that can correspond to many situations smoothly. Moreover, we research about the ontological sharing between the robots with each different mechanism. (Fig.10)



We develop 1)I-space soft (on Linux and Win) and propose 2)Ontology network system architecture. We show how useful the proposed ontology network for actual systems (H.V. Sys.).

Fig 10 Network of different mechanism

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